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A Portable Atmospheric Sampling QUISTOR/reTOF- MS for Air Monitoring

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We are developing a portable mass spectrometer to detect volatile organic compounds in air. Given sufficiently low detection limits and high mass resolution, such an instrument will be useful in a wide array of air monitoring applications, for example, pollutant detection. We chose a time-of-flight analyzer for its efficient ion transmission with virtually unlimited mass range. We use a quadrupole ion storage trap to create a pulsed source to provide a reference for ion flight times. Through its ion storage capability, the ion trap also lowers detection limits, enhances sensitivity and increases the duty cycle of the instrument. The flight tube houses a reflectron, which improves mass resolution by partially compensating for the kinetic energy spread of the ions. The ion trap is coupled to the flight tube via an einzel lens. An important feature of the new instrument is that the air sample is introduced directly. This eliminates the need for vacuum interlocks and various hardware associated with other types of sample inlet. Such a sampling system also reduces contact between the analyte and surfaces inside the instrument, thus greatly decreasing the loss of sample through adsorption onto the walls of the inlet, or through catalytic decomposition arising from such adsorption.

To aid the design of the portable instrument, various features were tested in a larger laboratory instrument. Based on these tests, we have chosen to use electron impact to ionize the sample. Also, we have designed an inlet which introduces the sample directly into the ion trap, so that the ions are formed within the trap instead of being injected externally. This may reduce the initial kinetic energy spread of the ions, and it offers lower detection limits. The various ion optics were modeled by means of the SIMION program and tested on the laboratory instrument. Then similar optics were designed for the portable instrument. To make the spectrometer portable, we have shortened the flight tube from 32in to 18in, and have made the ion trap envelope smaller.

For volatile organic compounds, the laboratory spectrometer has shown detection limits in the low to sub-ppb range (v/v) with mass resolution of 2000 or better (M/dM, FWHM). We expect the portable instrument to meet or exceed these specifications, and we hope to extend the detection limits to the mid to low ppt range with similar mass resolution.

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